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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte THOMAS WERNER, HARTMUT RUELKE, and
CHISTOF STRECK

Appeal 2009-003355
Application 10/691,274
Technology Center 1700

Decided: September 24, 2009

Before TERRY J. OWENS, PETER F. KRATZ, and MARK NAGUMO, *Administrative Patent Judges*.

OWENS, *Administrative Patent Judge*.

DECISION ON APPEAL

STATEMENT OF THE CASE

The Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's rejection of claims 1-5, 7-15 and 17-24, which are all of the pending claims. We have jurisdiction under 35 U.S.C. § 6(b).

The Invention

The Appellants claim a method which, the Appellants state, relates "to the formation of metallization layers including metals, such as copper, embedded into a dielectric material having low permittivity to enhance device performance" (Spec. 2:7-8). Claim 1 is illustrative:

1. A method, comprising:

forming a low-k dielectric layer over a substrate;

heat treating said substrate to promote out-gassing of volatile materials for a predetermined period of time after forming the low-k dielectric layer;

converting an upper portion of said low-k dielectric layer into a protective dielectric to form a sacrificial cap layer after heat treating said substrate; and

patterning said sacrificial cap layer and said low-k dielectric layer.

The References

Vines	5,610,105	Mar. 11, 1997
McGahay	6,348,736 B1	Feb. 19, 2002
Jiang	2002/0090822 A1	Jul. 11, 2002

The Rejections

The claims stand rejected under 35 U.S.C. § 103 as follows: claims 1-5, 11-15, 23 and 24 over McGahay in view of Vines, and claims 7-10 and 17-22 over McGahay in view of Vines and Jiang.

OPINION

We reverse the rejection of claims 1-5, 11-15, 23 and 24 and affirm the rejection of claims 7-10 and 17-22. Under 37 C.F.R. § 41.50(b) we enter a new rejection of claims 1-5, 11-15, 23 and 24.

Rejection of claims 1-5, 11-15, 23 and 24 over McGahay in view of Vines

Issue

Have the Appellants shown reversible error in the Examiner's determination that the applied prior art would have rendered prima facie obvious, to one of ordinary skill in the art, forming a low-k dielectric layer over a substrate and then heat treating the substrate to promote out-gassing of volatile materials?

Findings of Fact

McGahay forms in situ thin protective oxide on a silsesquioxane (SSQ) low-k dielectric layer to protect it from attack by developing solutions during resist patterning (col. 1, ll. 28-30; col. 2, ll. 55-58; col. 3, ll. 66-67; col. 5, ll. 41-43). A thin protective oxide layer (16) is formed by exposing the SSQ layer to an oxygen-containing plasma (col. 3, l. 66 – col. 4, l. 10; Fig. 2), and an extremely thin protective oxide film (40) subsequently is formed on a different portion of the SSQ layer during etching of the SSQ layer (col. 4, ll. 47-50; col. 5, ll. 40-58; Fig. 6).

Vines deposits a silicon dioxide dielectric layer by a water-tetraethylorthosilicate (TEOS) plasma enhanced chemical vapor deposition (PECVD) process, vacuum bakes to minimize or eliminate volatile species such as water, hydrogen and hydrocarbon impurities in the silicon dioxide layer, and then oxygen anneals to remove any remaining hydrocarbon in the

silicon dioxide layer and to improve the silicon dioxide quality (col. 2, ll. 32-40; col. 3, ll. 18-25; col. 3, l. 43 – col. 4, l. 49). The vacuum bake followed by oxygen anneal "provides a more reliable film, with less tendency to exhibit a charging effect (V_t shift) in the finished device" (col. 4, ll. 50-59).

Analysis

The Appellants argue that "[t]here are no process or chemistry similarities between McGahay and Vines that would lead one of ordinary skill in the art to combine them in the manner suggested by the Office Action" (Br. 8).

The Examiner argues that "it would have been obvious to a skilled artisan to have modified McGahay by employing the process of heat treating the substrate with the dielectric layer at the claimed pressure as taught by Vines because Vines, in col[.] 4, lines 50-59, discloses that the anneal process performed on the dielectric layer provides a more reliable film with less tendency to exhibit a charging effect in the finished device" (Ans. 5).

Vines' reliable film having less tendency to exhibit a charging effect in the finished device is a film of silicon dioxide (col. 4, ll. 50-51) which, it is undisputed, is not a low-k dielectric. The Examiner has not established that one of ordinary skill in the art would have desired to apply to a low-k dielectric Vines' process for removing water, hydrogen and hydrocarbon impurities from silicon dioxide.

Conclusion of Law

The Appellants have shown reversible error in the Examiner's determination that the applied prior art would have rendered prima facie obvious, to one of ordinary skill in the art, forming a low-k dielectric layer

over a substrate and then heat treating the substrate to promote out-gassing of volatile materials.

New rejection of claims 1-5, 11-15, 23 and 24

Under 37 C.F.R. § 41.50(b) we enter the following new rejection of claims 1-5, 11-15, 23 and 24.

Claims 1-5, 11-15, 23 and 24 are rejected under 35 U.S.C. § 103 over Jiang in view of McGahay.

Claims 1 and 11: Jiang discloses a method for patterning low-k dielectric films (¶ 0001), comprising:

forming a low-k dielectric layer over a substrate (interlevel dielectric (ILD) 102 and intrametal dielectric (IMD) 104 over semiconductor body 100; ¶¶ 0016-17) (regarding claim 11, Jiang's exemplified low-k dielectric layer is silicon based (col. 1, ll. 28-30)),

heat treating the substrate to promote out-gassing of volatile materials for a predetermined period of time after forming the low-k dielectric layer ("The low-k film is treated with a plasma using oxidation-type reactions to eliminate or significantly reduce resist poisoning.... this treatment can be applied to as-deposited low[-]k films before patterning" (¶ 0005)). "The cause of resist poisoning is believed to be the interaction between the DUV [deep ultraviolet] resist and nitrogen-containing reagents from the low-k films. Possible sources of nitrogen include: the low-k film, the dielectric cap and optional IMD etch-stop layers (e.g., SiN) and/or chemistries used in the deposition of these films, N_2 in the clean (ash) process, N_2 in the etch chemistry, and the photoresist itself" (¶ 0011). "In order to reduce or eliminate the resist poisoning, a plasma treatment using oxidation reactions is performed" (¶ 0012). "The plasma process conditions are designed to

remove nitrogen in the film that may have been introduced during its deposition or during subsequent processing and therefore prevent resist poisoning" (¶ 0014). The plasma process chuck temperature is about 40°C (¶ 0013),

optionally forming a capping layer, which typically comprises silicon nitride, a silicon oxide, silicon oxynitride, Si-rich nitride or SiC, over IMD 104 (¶ 0017) (Jiang's disclosure that the material above IMD 104 is removed (¶ 0027; Fig. 1F) indicates that the capping layer is a sacrificial layer), and

patterning the capping layer (if present) and the low-k dielectric layer (¶¶ 0020, 0024; Figs. 1D, 1E).

Jiang does not disclose how the capping layer, which can be silicon dioxide (¶ 0017), is formed. Therefore, one of ordinary skill in the art would have used one of the known methods for forming a silicon dioxide layer on a low-k dielectric such as McGahay's in situ method wherein the low-k dielectric is exposed to an oxygen-containing plasma (col. 3, l. 66 – col. 4, l. 10).

Jiang does not disclose that the capping layer is formed after the plasma treatment to remove nitrogen from the film. However, because forming a silicon dioxide capping layer would not introduce nitrogen into the low-k dielectric film, Jiang would have led one of ordinary skill in the art, through no more than ordinary creativity, to form the silicon dioxide capping layer either before or after the plasma treatment. *See KSR Int'l. Co. v. Teleflex Inc.*, 550 U.S. 398, 418 (2007) (In making an obviousness determination one "can take account of the inferences and creative steps that a person of ordinary skill in the art would employ"). Because the substrate

and low-k dielectric layer are heated during McGahay's in situ silicon dioxide layer formation to a much higher temperature than the temperature during Jiang's plasma treatment for removing nitrogen from the low-k dielectric film (350-400°C (McGahay, col. 4, ll. 3-10) versus about 40°C (Jiang, ¶ 0013)), it appears that, as required by the Appellants' claim 11, outgassing from the low-k dielectric layer would continue during the formation of the silicon dioxide capping layer.

Claims 2, 3, 12 and 13: McGahay's method forms a silicon dioxide dielectric layer on a low-k dielectric by exposing the low-k dielectric and the substrate to an oxygen-containing plasma (col. 3, l. 66 – col. 4, l. 10).

Claims 4, 5, 14 and 15: It would have been apparent to one of ordinary skill in the art that forming Jiang's capping layer by oxidizing the upper surface of the low-k dielectric layer using McGahay's method would require forming the low-k dielectric layer with a thickness that exceeds the desired final low-k dielectric layer thickness by the thickness of the capping layer that is formed from the upper portion of the low-k dielectric layer and is subsequently removed.

Claims 23 and 24: Jiang's heat treatment to remove nitrogen from the low-k dielectric film is at a pressure of about 150 millitorr (¶ 0013).

Rejection of claims 7-10 and 17-22 over McGahay in view of Vines and Jiang

Issue

Have the Appellants shown reversible error in the Examiner's determination that the applied prior art would have rendered prima facie obvious, to one of ordinary skill in the art, out-gassing heat treatment followed by formation of a cap layer?

Analysis

The Appellants argue that "Jiang also teaches a cap layer formation step without a preceding heat treatment out-gassing step" (Br. 9).

Jiang's disclosure that the capping layer is optional and can be a material other than an oxide (¶ 0017) indicates that Jiang's oxygen plasma process does not form a capping layer. As set forth above regarding the new rejection of claims 1 and 11, because forming a silicon dioxide capping layer would not introduce nitrogen into the low-k dielectric film, Jiang would have led one of ordinary skill in the art, through no more than ordinary creativity, to form the silicon dioxide capping layer by a method such as that of McGahay either before or after the plasma outgassing treatment. *See KSR*, 550 U.S. at 418 (In making an obviousness determination one "can take account of the inferences and creative steps that a person of ordinary skill in the art would employ").

Conclusion of Law

The Appellants have not shown reversible error in the Examiner's determination that the applied prior art would have rendered prima facie obvious, to one of ordinary skill in the art, out-gassing heat treatment followed by formation of a cap layer.

DECISION/ORDER

The rejection of claims 1-5, 11-15, 23 and 24 under 35 U.S.C. § 103 over McGahay in view of Vines is reversed. The rejection of claims 7-10 and 17-22 under 35 U.S.C. § 103 over McGahay in view of Vines and Jiang is affirmed. Under 37 C.F.R. § 41.50(b) a new rejection of claims 1-5, 11-15, 23 and 24 has been entered.

It is ordered that the Examiner's decision is affirmed-in-part.

In addition to affirming the examiner's rejection(s) of one or more claims, this decision contains a new ground of rejection pursuant to 37 CFR § 41.50(b) (effective September 13, 2004, 69 Fed. Reg. 49960 (August 12, 2004), 1286 Off. Gaz. Pat. Office 21 (September 7, 2004)). 37 CFR § 41.50(b) provides "[a] new ground of rejection pursuant to this paragraph shall not be considered final for judicial review."

37 C.F.R. § 41.50(b) also provides that the appellant, WITHIN TWO MONTHS FROM THE DATE OF THE DECISION, must exercise one of the following two options with respect to the new ground of rejection to avoid termination of the appeal as to the rejected claims:

> (1) Reopen prosecution. Submit an appropriate amendment of the claims so rejected or new evidence relating to the claims so rejected, or both, and have the matter reconsidered by the examiner, in which event the proceeding will be remanded to the examiner. . . .
>
> (2) *Request rehearing*. Request that the proceeding be reheard under § 41.52 by the Board upon the same record. . . .

Should Appellant elect to prosecute further before the Examiner pursuant to 37 C.F.R. § 41.50(b)(1), in order to preserve the right to seek review under 35 U.S.C. §§ 141 or 145 with respect to the affirmed rejection, the effective date of the affirmance is deferred until conclusion of the prosecution before the Examiner unless, as a mere incident to the limited prosecution, the affirmed rejection is overcome.

If Appellant elects prosecution before the Examiner and this does not result in allowance of the application, abandonment or a second appeal, this case should be returned to the Board of Patent Appeals and Interferences for

final action on the affirmed rejection, including any timely request for rehearing thereof.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED-IN-PART, 37 C.F.R. § 41.50(b)

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